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Engineering Assessment of Solid Waste Management Practices in Obafemi Awolowo University, Ile-Ife, Nigeria

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ABSTRACT

Solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in developing and under developing countries. The rate of generation of waste over the years was not matched by corresponding waste management efforts. This led to the emergence of improper solid waste disposal around the globe. This study focused on the engineering assessment of solid waste management and solid waste characterization in the study area. The study investigated the efficiency of the current solid waste management practices in the study area while also characterizing the various components of solid wastes. Engineering assessment of solid waste management practices in the university were conducted through the use of questionnaires, conducting oral interviews and executing major field works in order to determine the various components of solid generated, methods of storage, transportation, reduction, disposal, recycle and reuse. Samples were collected from seven random locations so as to determine the average solid waste characterization in the study area. Questionnaires and oral interviews were directed to the solid waste management unit which further explains the results obtained from the field observation of the various components of the solid waste management in the study area. This results from this study presents the current solid waste management practices to be average which was due to the incompetence on the part of workers and equipment employed. Paper, plastic, metals and bottles are the most predominant components of the solid waste generated in the study area which further highlights the main purpose it serves. Polythene, putrescible and fabric are mostly predominant in halls of residence and new bukateria.

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INTRODUCTION

Wastes are substance or objects, which are disposed of, or are intended to be disposed of, or are required to be disposed of by the provisions of national law (Akinduntire, 2004).. Waste is everything that no longer has use or purpose and needs to be disposed of, right? Right. The term certainly applies to discarded material, but there are specific definitions for waste that affect how waste is managed and must be handled, especially in professional settings (Ogwuleleka, 2009).

Wastes are unwanted or unusable materials. Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. (Gandy, 1994). Waste can be solid, liquid, or gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial. biological and household. In some cases, waste can pose a threat to human health. Waste is produced by human activity, for example, the extraction and processing of raw materials. Waste management is intended to reduce adverse effects of waste on human health, the environment or aesthetics (Akinduntire, 2004).

Over the years, studies have shown that rapid population growth and the growth of urban centres which followed the oil boom in the 1970's and industrialization came with a change in waste stream in Nigeria. This was as a result of increased use of goods to satisfy and meet the need of the teeming population resulting in the substantial increase in the

amount of wastes generated. It is therefore important to note that waste generation and population growth work hand-in-hand Badi *et al*., (2016).

Waste collection methods vary widely among different countries and region. Domestic waste collection services are often provided by local government authorities or by private companies for industrial and commercial waste. Some areas, especially those in less developed countries, do not have formal waste-collection systems (Chai *et al*., 2013; Omran *et al*., 2017). .

An important method of waste management is the prevention of waste material being created, also known as waste reduction (Jovanović *et al*., 2016). Methods of avoidance include reuse of second-hand products, repairing broken items instead of buying new ones, designing products to be refillable or reusable (such as cotton instead of plastic shopping bags). encouraging consumers to avoid using disposable products (such as disposable cutlery), removing any food/liquid remains from cans and packaging, and designing products that use less material to achieve the same purpose (Chatterjee et al., 2018).

The management of waste is a key component in a business ability to maintain ISO14001[1] accreditation. The standard encourages companies to improve their environmental efficiencies each year by eliminating waste through resource recovery practices. One way to do this is by adopting resource recovery practices like recycling materials such as glass, food scraps, paper and cardboard, plastic bottles and metal. Recycled materials can often be sold to the construction industry. Many inorganic waste streams can be used to produce materials for construction. Concrete and bricks can be recycled as artificial gravel (Generowicz *et al*., 2011).

This project is concerned with the problems and alternative solutions of effective solid waste management practices in Obafemi Awolowo University.

MATERIALS AND METHODS

The Area of Study

The area of study is Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. The university is situated geographically within the rain forest zone, on latitude $7^0 28'$ N and longitude $4°33'$ E at about 200 m above sea level. It covers a land area of 11,855 hectare with its central campus covering 112 hectares.

The research work covered the entire campus ranging from halls of residence, faculties and departments, administrative buildings, central market, dumpsite amidst others. The research work does not cover the university's staff quarters and locations outside the central campus.

Methods

This research work adopted the following methods in carrying out the investigations on evaluating solid waste management practices in the university and ways of improving it through the use of questionnaires; conduct oral interviews (formal and informal). Field studies were carried out which entails characterizing solid wastes in the university, physically observing the waste management procedures in the university and assessing the environmental impacts of improper solid waste management on the university and its neighbouring communities.

Field Work

The following field works were carried out during the course of this research work.

Characterization of solid waste

This was carried out to determine the major components of solid waste generated in the university. The following procedures were carried out:

i. Samples were obtained from different locations in the university. An approximate amount of solid waste in the region of 3000 g was utilized.
ii. Each component was weighed and their respective weights were recorded. This procedure was carried out for remaining samples taken from other locations.
iii. The percentage of each component was determined from the total weight of the sample obtained at each location.
iv. The average percentage of the components for the university was computed.

Examining the patterns of solid waste collection and disposal

This includes physically observing the ways through which solid waste are collected, transported and disposed. The number of times these operations are done were also observed and the time during which these operations are done on a daily basis.

Assessment of the university solid waste management

Physical assessments of the various units of the Solid Waste Management were carried out to check the efficiency of the system

Environmental impacts of solid waste disposal on the university and its environs

The impacts of improper solid waste disposal were examined in the university and nearby communities so as to check if there is a record on occurrence of

diseases in the university health center which may be due to the improper disposal which may be done by the university solid waste management department.

Conduct Oral Interviews

This research employed the use of oral interviews (formal and informal) from concerned authorities to inquire about:

i. The number of manpower employed by the University for Solid Waste Management Practices.
ii. The number and efficiency of equipment used in the university's solid waste management practices.
iii. The type and capacity of the vehicles used for transportation of solid waste.
iv. The current condition of the incinerators at the dumping site and ways or rehabilitating them or constructing new ones if totally damaged.
v. The effects of open dumping and burning of solid wastes on the neighbouring environments.
vi. How solid waste reduction (sorting) are done.
vii. Where the sorted solid wastes are being used and the reasons for which they are used.
viii. Suggestions that would help in the effective management of solid waste in the university and its environs.

Use of Questionnaires

This research employed questionnaires to study:

i. How solid wastes are generated in the university.
ii. How solid wastes are being stored and modes of its storage in the university.
iii. How solid wastes are being collected and transported in the university.
iv. The methods of disposal employed by the university.
v. The efficiency of methods of disposal employed by the university.
vi. How solid wastes can be reduced (sorting of solid wastes).
vii. How the sorted solid wastes (plastic bottles, cans and other valuable wastes) can be reused and recycled.
viii. The impacts of improper solid waste disposal on the neighbouring communities.
ix. Ways on which solid waste management practices can be improved in university and Nigeria at large.

The Questionnaire was tested using statistical packages for social sciences (Chi-Square) methods to determine the relationship between solid waste management and environmental impact on health.

RESULTS AND DISCUSSION

The coordinates of areas under consideration are shown in Table 1.

Solid Waste Characterization

Characterization of solid wastes was carried out in seven (7) different locations which are Awolowo Hall, Angola Hall, Moremi Hall, New Bukateria/ETF Hall. Student Union Building, Faculty of Pharmacy and Faculty of Agriculture. These locations were chosen as they are evenly distributed within the university and large amounts of wastes are generated in these areas. Two samples were obtained in the region of 3000g from each location and the average of the two samples was calculated and was used in characterizing the solid waste. The results obtained from these characterizations are presented in Figures 1 – 6. Figure 7 shows the average solid waste components for the entire university.

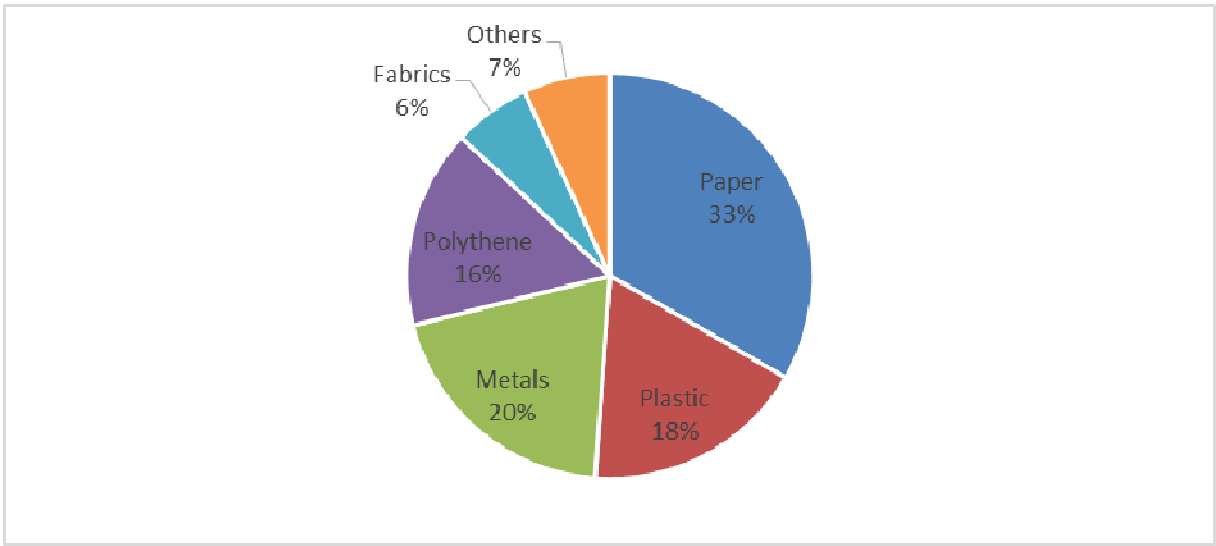

Figure 1: Graphical representation for Angola Hall's solid waste characterization

Table 1: Coordinates of the selected areas

S/N	Location	Latitude	Longitude
1	Alumni Hall	7.5218339°	4.51744505°
2	Angola Hall	7.5215211°	4.5132341°
3	Awolowo Hall	7.520737°	4.5151777°
4	Civil Engineering Building	7.523078°	4.5290584°
5	Chemical Engineering Building	7.5192373°	4.5283047°
6	Faculty of Administration	7.5203587°	4.5223523°
7	Faculty of Agriculture	7.5222637°	4.5261426°
8	Faculty of Pharmacy	7.5169763°	4.5266424°
9	Fajuyi Hall	7.5184558°	7.5184558°
10	Health Centre	7.52023333°	4.516700°
11	Moremi Hall	7.520406°	4.5183383°
12	New Bukateria/ETF Hall	7.5181168°	4.5148427°
13	Student Union Building	7.51753741°	4.5208006°
14	Tonkere Disposal Site	7.5279076°	4.5284385°
15	1000 Seater Lecture Theatre	4.5284385°	4.5196369°

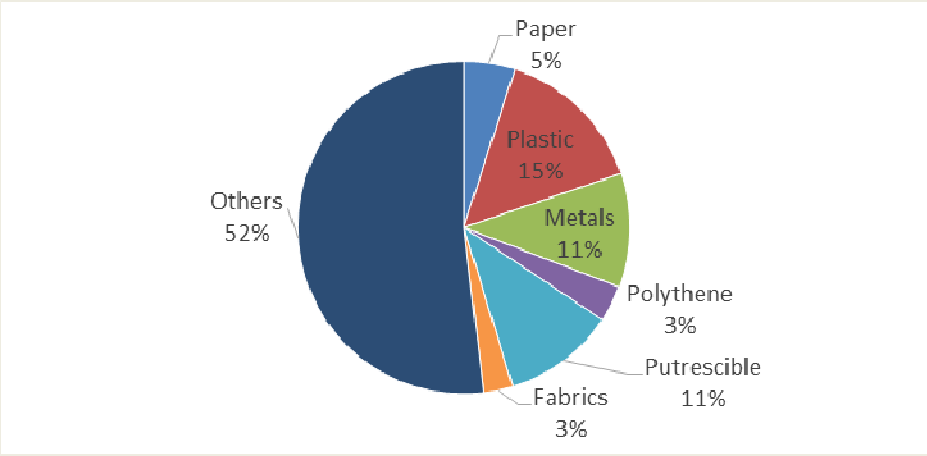

Figure 2: Graphical representation for New Bukateria/ETF Hall's solid waste characterization

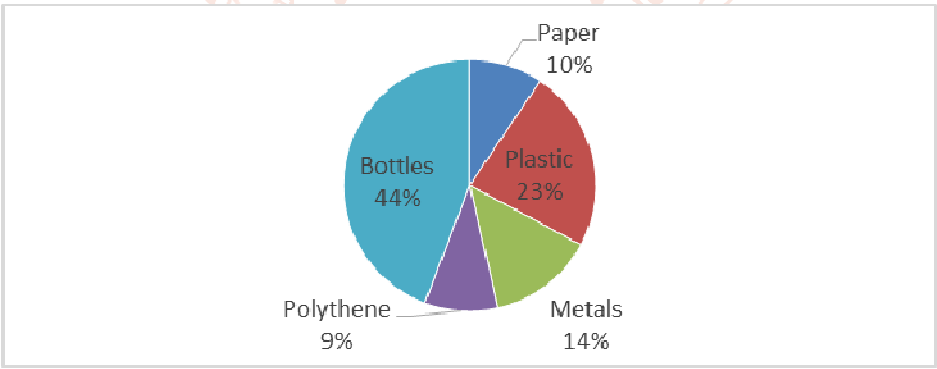

Figure 3: Graphical representation for Student Union Building's solid waste characterization

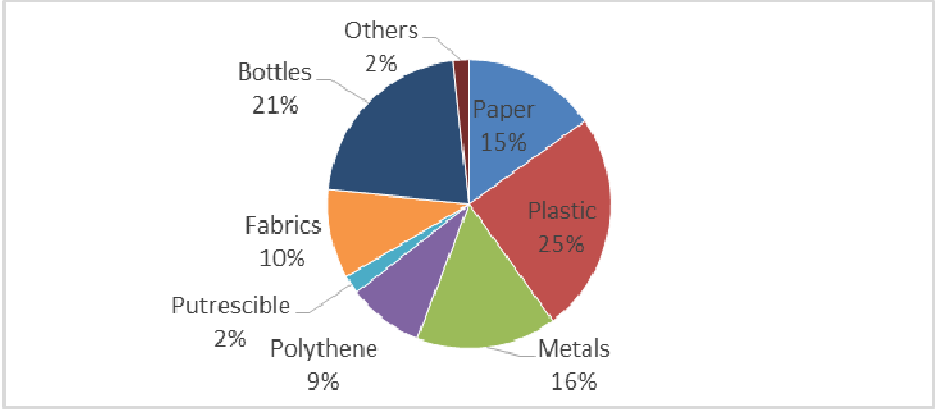

Figure 4: Graphical representation for Awolowo Hall's solid waste characterization

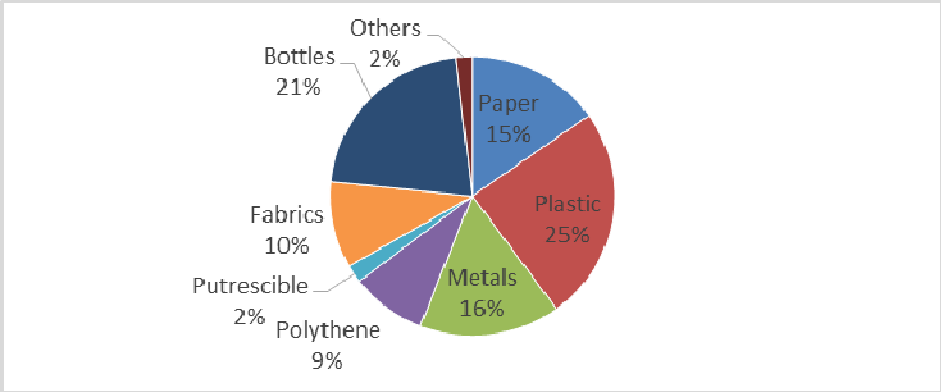

Figure 5: Graphical representation for Faculty of Pharmacy's solid waste characterization

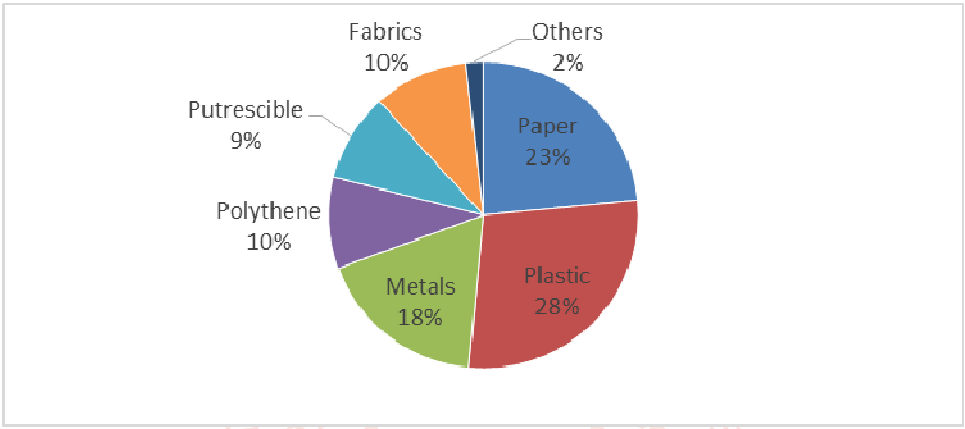

Figure 5: Graphical representation for Faculty of Agriculture's solid waste characterization

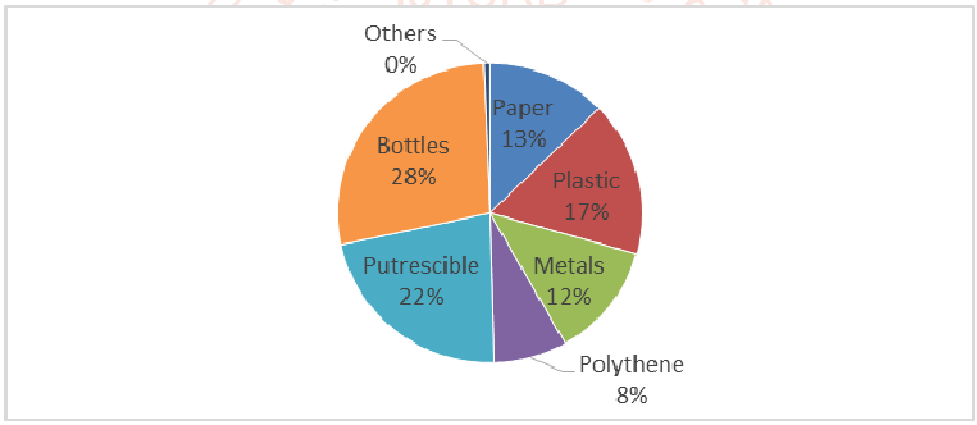

Figure 6: Graphical representation for Moremi Hall's solid waste characterization

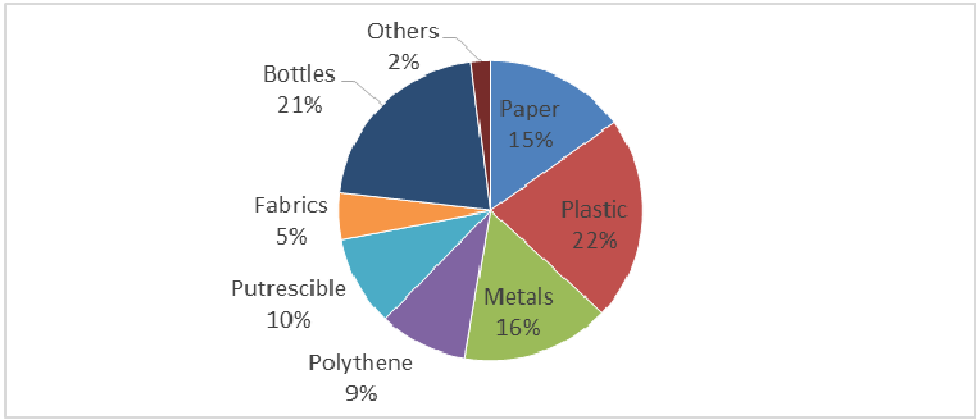

Figure 7: Graphical representation for the university's solid waste characterization

Environmental Health Unit

This is the unit that is responsible for the management of waste within O.A.U. community. This unit is under the university' s medical and health services department. The collection of solid waste adopted by the unit within the university is the use of metallic refuse dumpsters. These refuse dumpsters are placed between structures to serve these structures.

Solid Waste Management in Obafemi Awolowo University

Solid waste storage

The storage method adopted was through the use of waste bins mostly plastic which were provided by staff or student bodies. The university management also made provisions for metallic waste bin which is 0.025 m^3 in volume, which are suspended at various points within the university including halls of residence. Waste bins of sizes ranging between 0.021 m^3 and 0.072 m^3 in volume are also provided by those transacting business within the central campus. Large drums are used for storing solid waste in commercial places such as O.A.U. central market, halls of residence, eateries around the campus.

Solid waste collection

Solid wastes are usually collected in dumpsters placed at strategic locations in the university. Dumpsters are currently being used in thirteen (13) different locations to collect solid waste from bins within close proximity so as to convey these wastes to the disposal site. The university environmental health uses two different types of dumpsters which are the open-top dumpster and the metallic closed dumpster. Table 2 shows the location, the volume of dumpster used, the average day it takes to be filled and the average day it takes before the solid wastes are carted away. The volume of the metallic dumpster and open-top dumpster are 4.36 m^3 and 0.71 m^3 respectively. Solid wastes arc collected from various dumpsters averagely every 4 - 5 days or simply put as once a week.

Solid waste transportation

Solid wastes are mainly transported to the disposal site through the means of a lorry and a tractor. Both mode of transports is used to cart solid waste on a daily basis, the tractor averages about 3 - 4 trips while the lorry only carts solid waste once in a day. The lorry is approximately 8.3 m^3 in volume while the tractor carries a 4.36 m^3 dumpster. The transportation system provided for carting away solid wastes cannot effectively manage the amount of solid wastes being generated on a daily basis which in turns lead to several dumpsters being filled without being carted for days.

Table 2: Dumpster Location and Characteristics

Location of dumpsites	Volume of dumpsters (m^3)	Number of dumpsters	Average days it takes to be filled	Average number of days before waste is carted away for disposal
Chemical Engineering Building	0.71 4.36	1 1	2	5
Fajuyi Hall	4.36	1	2	4
Alumni Hall	4.36	1	3	4
New Bukateria	4.36	2	2	4
Angola Hall	4.36	1	2	4
Civil Engineering Building	4.36	1	4	5
Awolowo Hall	4.36	1	2	4
Student Union Building	4.36	1	2	4
Faculty of Pharmacy	4.36	1	3	4
Faculty of Administration	4.36	1	2	4
Faculty of Agriculture	4.36	1	4	5
1000 Seater Lecture Theatre/Geology car park	0.71	2	2	4
Moremi Hall	4.36	2	2	4

Solid waste reduction

Solid wastes are usually reduced through sorting of solid wastes that are to be recycled and reused by different organisations. Each organisation employ the services of one or more scavengers to help in sorting the solid wastes, which in turns result in reducing the amount of solid wastes to be disposed by the environmental unit. There is also a renumeration paid to the university management by these organisations. At the time of writing this report, there are two (2) organisations that are contracted to the university for obtaining solid wastes.

Solid waste disposal

The university utilizes open dumping (burning) method as its main method of disposing solid wastes. The waste disposal site is located at Tonkere Road, along Road 9, Obafemi Awolowo University, Ile-Ife. There are two incinerators and a sorting house which are currently abandoned and has turned into an abode for scavengers owing to the fact that the amount of solid waste generated on a daily basis cannot be incinerated in the incinerator which is mainly due to its small size. According to the person in charge of burning the waste, burning does not have significant impact on the volume of the waste as most of the wastes are left unburnt which is a growing concern and has forced the university to employ the services of a bulldozer to push wastes to the downward part of the disposal site.

Health and Environmental Impacts of Solid Waste Management

Abstract deteriorating soil quality and decrease in vegetation abundance is a grave consequence of open waste dumping which have resulted in growing public concern in recent times. Open dumping methods of disposing solid waste are creating serious negative impacts in the university. The following negative impacts are being observed due to open dumping of solid waste in the university:

i. **Leachate:** Percolating rainwater through the open dump contaminating ground water resources.
ii. **Odour:** Nearby areas to the dump site is being affected due to odour emitting from these dumps.
iii. **Dust and filthy dirt:** Strong wind and storm are spreading dust and filth from open dumps of solid waste to adjacent areas in the university and in neighbouring communities.
iv. **Health and sanitation:** Open dumps of solid waste are a serious threat to human health and sanitation. Burning of solid waste can also create drastic air pollution which may be injurious to health.

Questionnaire's Hypothesis Analysis Using Chi-square

Hypothesis 1

H_0: There is no significant association between waste management and clean environment in the study area.

H_1: There is a significant association between waste management and clean environment in the study area.

Significance level = 0.05

Critical region: Accept H_0, if P-value is greater than the significance value, otherwise accept H_1. The chi-square analysis in Table 3 shows that the p-value (0.0108) is less than the significance value (0.05). We can therefore accept the alternative hypothesis and reject the null hypothesis and conclude that there is a significant association between waste management and clean environment in the study area. Table 3 shows the association between waste management and clean environment in the study area.

Table 3: Association between Waste Management and Clean Environment in the Study Area

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	68.167[a]	19	.306
Likelihood Ratio	45.546	19	.952
Linear-by-Linear Association	2.587	1	.0108
N of Valid Cases	20		

a. 60 cells (75 %) have expected count less than 5. The minimum expected count is .05

Hypothesis 2

H_0: There is no significant association between waste management and environment hazards in the study area.

H_1: There is a significant association between waste management and environment hazards in the study area.

Significance level = 0.05

Critical region: Accept H_0, if P-value is greater than the significance value, otherwise accept H_1.

The chi-square analysis below shows that the p-value (0.047) is less than the significance value (0.05). We can therefore accept the alternative hypothesis and reject the null hypothesis and conclude that there is a significant association between waste management and environment hazards in the study area. Table 4 shows the association between waste management and environment hazards in the study area.

Table 4: Association between Waste Management and Environment Hazards in the Study Area
Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	68.432[a]	19	.089
Likelihood Ratio	45.382	19	.792
Linear-by-Linear Association	3.960	1	.047
N of Valid Cases	20		

a. 70 cells (85.0 %) have expected count less than 5. The minimum expected count is .05

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study successfully demonstrates that the distribution of solid wastes within Obafemi Awolowo University in percentages is as follows plastics 22 %, bottles 21 %, metals 16 %, paper 15 %, putrescible 10 %, polythene 9 %, fabrics 5 % and others 2 %. The percentage of paper and polythene is high in academic areas thereby highlighting the high usage of these materials in academic areas. The percentage of putrescible and fabrics solid wastes are slightly high in halls of residence and central market highlighting there are much rotten materials present in these places. The solid waste management practices were found to be inadequate and lagging in many areas which need to be addressed. Limited number of staffs and personnel to manage the solid waste generated in the university effectively is of growing concern. Also, the disposal method employed by the university which is the open dumping/burning method is hazardous to the environment and has adverse effects on soil strata within and surrounding areas of the dumpsite

Recommendations

With reference to the research work and conclusions drawn, the following recommendations is proffered for the effective management of solid waste within Obafemi Awolowo University, Ile-Ife, Nigeria.

i. Better pay packages for various workers working in the solid waste management. units which will go a long way to motivate the staffs to work better.

ii. The university management should enlighten its populace about effective handling and management of solid waste through organising of seminars and programmes.

iii. Collection of solid waste should be done as quickly as possible to remediate the occurrence of solid waste spilling in dumpsters.

iv. New dumpsters should be provided as most dumpsters are and do not have the capability of storing waste generated on a daily basis.

v. Adequate collection facilities and safety equipment should be provided for the workers which will surely increase their level of productivity.

vi. Adequate transport facilities should be incorporated so as to make the transportation of solid waste much easier.

vii. New incinerators should be constructed as both incinerators do not have the capability to incinerate solid waste generated on a daily basis in the university.

viii. A new site for disposal of solid waste should be provided, but most preferably should be operated as a sanitary landfill as they do not have adverse effects on the environment.

ix. Concerned authorities should be trained and attend workshops on how to effectively manage solid waste.

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